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and Kathy Larson

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Taking into Account Carbon Sequestration of Pasture in Carbon Balance of Cattle Ranching Systems Established after Deforestation in Amazonia

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Introduction

Livestock development in the Amazonian basin has fuelled a lively international debate in recent decades. According to the FAO, approximately 80% of deforested areas were converted into pastures resulting in rapid carbon (C) emissions (~ 733 $tCO_2eq.\ ha^{-1}$) (Blanfort et al., 2014). Thus, efforts to curb deforestation should continue to be a priority to preserve C stocks and forest biodiversity. In addition, this also needs to be accompanied by sustainable management of areas that were converted into pastures, including strategies for greenhouse gas (GHG) mitigation. Few references are available in tropical areas and there is still important work to be done to establish the baselines and strategies to support sustainable grazing activity in these regions. In French Amazonia, a regional research platform contributes to the Carbon Observatory (GEC) aiming to provide solutions to these problems. The first stage of research focuses specifically on how cattle ranching systems affect C stocks in pastures where *Brachiaria* spp. is the dominant implanted grasses following deforestation. The eddy covariance flux measurements and a chronosequence study in 2012-13 showed that pastures issued from deforestation two decades after their introduction stored in the soil between 6.4 and 19.4 ± 7.7 $tCO_2eq.\ ha^{-1}\ yr^{-1}$ (Blanfort and al., 2014 ; Stahl and al., 2016). Considering these results, a second phase of research, presented in this article, consists of establishing C/GHG balance and efficiency of livestock systems of French Guiana.

Materials and Methods

Data were collected on 8 cattle farms from the French Livestock Institute network representing 3 typical stages of development of Guiana's livestock: 2 small land owners (SLO), 3 developing farms (DF) and 3 large land owners (LLO). Direct and indirect GHG emissions from farm scale (CO_2, N_2O and CH_4) were calculated in 2013 using the ACCT method (a tool for energy and emissions analysis in farms based on different international standards and protocols, AgriClimate Change project, 2013). According to specific studies led in Guiana (Stahl and al., 2016), C sequestration from grassland in 2013 is considered as null for recent pastures, and of 6.4 $tCO_2eq.\ ha^{-1}\ yrs^{-1}$ for those of more than 24 years old. The GHG emissions resulting from the past conversion from forest to grassland (C stock variations on the aerial and underground compartments) are estimated using a tier 2 IPCC method (Fig 1). Livestock systems of Guiana are compared to i) an extensive ranch in central Africa based on traditional use of natural *Hyparhenia* spp. savanna and *Brachiaria* spp. improved grasslands (Lecomte, 2015), ii) Brasil Amazonian cattle extensive farm (Clerc et al., 2012), iii) temperate grazing system.

Results and Discussion

GHG emissions from the livestock systems studied, varied in response to their degree of development. The GHG emissions of smallholders and developing farms (DF & SLO: 2.8±0.8 $tCO_2eq.\ ha^{-1}$) are close to the references of the Congo ranch on *Bracharia* spp. (2.3±0.5 $tCO_2eq.\ ha^{-1}$). However, the developed farms have greater emission rates (LLO: 5.1±1.0 tCO_2eq. ha^{-1}) close to systems in the French temperate area (5.6 tCO_2eq. ha^{-1}). Thus, the dynamic of development over time of farms (DF > LLO) seems to lead to an increase of GHG emissions per hectare, due to the rise in the stocking rate and inputs (fertilizers, oil consumptions etc…). Nevertheless, these stable systems (LLO) are characterised by a yearly C sequestration of older grasslands (i.e. >24 years old) that compensates on average for up to 80% of the GHG farm's emissions in 2013. GHG emissions linked to deforestation are mainly due to variations of C stocks of the aerial compartment (CO_2, N_2O, CH_4 emissions from the forest biomass combustion) (Fig. 1). The underground C stock variations are more important in deep soil than in the surface layers on farms where deforestation is most recent (RF). In stable farms (LLO), deforestation goes back more than 20 years and the conversion of forest into grassland induces an increase of C contained in the deep ground.

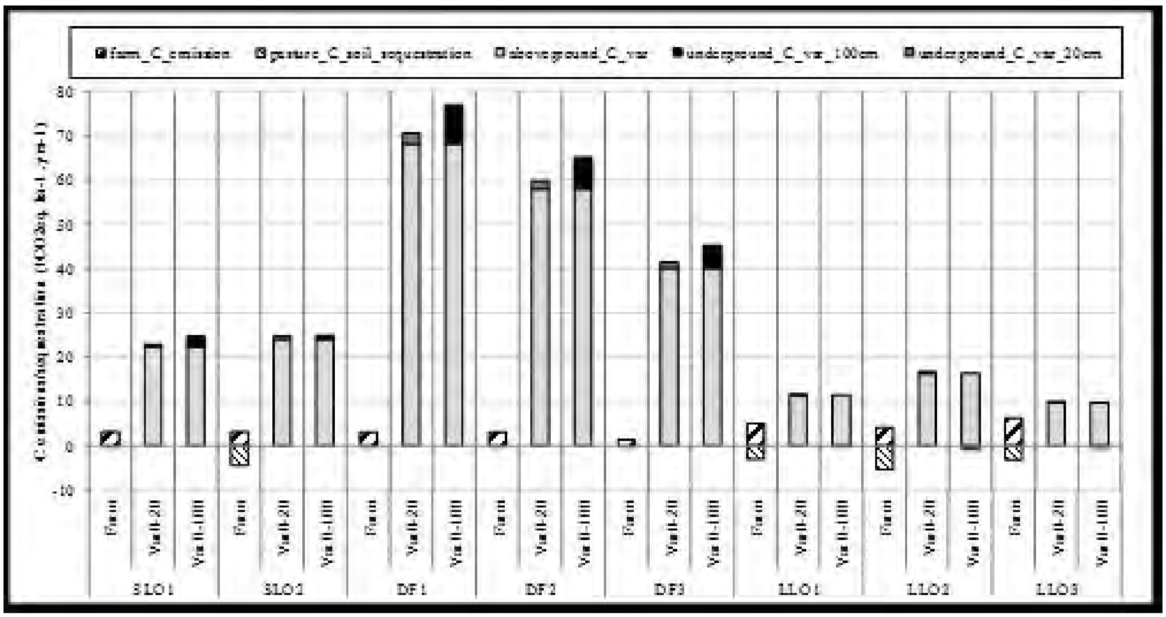

Figure 1. C emissions / sequestrations of 8 livestock systems in French Amazonia: C stock variations after deforestation (i) in the aboveground compartment (aboveground_C_var), ii) in the underground compartment for the first 20 cm (underground_20cm) and iii) on 1m of depth (underground_100cm).

Conclusions and Implications

In Amazonia, the current challenge is to manage the deforested areas to maintain the productivity of livestock systems alongside their capacity to mitigate GHG. This study offers to combine different methodological approaches incorporated in the diagnosis GHG tool of pasture systems. This tool allows to take into account the yearly direct and indirect emissions of livestock systems, grassland C sequestration, and the yearly GHG impact of deforestation. An increased effort in sampling, and a focus allowing to assess the impact of practices, would be necessary to confirm these tendencies, and will be the object of further studies. From a broader point of view, this study contributes to the emergence of references in the Amazonian basin, for a more sustainable management of deforested lands. This study also highlights the importance of considering deep soil layers in grassland's C balance establishment (according to Stahl and al., 2016), in comparison to the current IPCC method based by default on the first 30cm.

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